green is a simple Mendelian recessive to the normal, and a similar result was obtained in crosses between the striped forms known as *Zea japonica*, in crosses with the normal green strains, the striped being recessive to normal, though in the latter cross there is some confusion when certain differences in aleurone colors are also involved in the same cross. The exact nature of this relation between aleurone colors and leaf colors was not worked out. Crosses between striped plants and chlorina, and between striped and yellowish white yielded in each case normal green plants, owing to the bringing together of complementary factors.

MILES also made a study of the chloroplasts in the several strains with which he worked. He could find no plastids in the pure white seedlings, and only a few small plastids in the yellowish white, which became more numerous and larger as the plants grew older, until they resembled, in the better developed individuals, the normal condition. In the case of striped-leafed plants, the arrangement of the plastids showed a sharp distinction between the cells of the green portions of the plants and those of the white stripes.—G. H. SHULL.

The physiology of pollen.—In his work on the physiology of pollen, TOKUGAWA[5] dealt with three main points of interest: factors determining germination, factors determining the direction of the pollen tube, and factors determining the rate and extent of the growth of the pollen tube. The investigator adds evidence against the views of MOLISCH and of BURCH that specific substances on the stigma generally determine whether the pollen will germinate or not. Already many cases have been found in which the physical conditions are the important ones in determining germination. JOST showed for various species in several families that restricted water supply is the main requirement for the germination of the pollen. He secured this condition by germination of the pollen in a saturated atmosphere or on leaf epidermis or parchment paper. TOKUGAWA adds many more to the list. He has evidently failed, however, to notice the work of MARTIN,[6] which shows the important newly discovered fact that conditions giving a free water supply to the stigma may lead to sterility. This holds for alfalfa and certain clovers in the central Mississippi Valley when pollination occurs at moist or wet periods.

The author confirms the statement that sugars and proteins are important chemotropic substances for the pollen tube. In certain plants (*Narcissus Tazetti* and *Prunus mume*) sugars are effective, and in other (*Camellia japonica*) proteins. He concludes that chemotropism determines the entrance of the tube into the stigma canals and the micropyle, and that the tube is directed in a physical manner in the rest of its course.

The conditions affecting growth of the pollen tube are considered in relation to their significance in determining self-sterility and failure to

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[5] TOKUGAWA, Y., Zur Physiologie des Pollens. Jour. Coll. Sci. Tokyo **35**:1–35. *figs. 2*. 1914.

[6] BOT. GAZ. **56**:112–126. 1913.

hybridize. In this connection it is found that tubes penetrate rather deeply into agar. The work with several species of lilies shows that the tubes penetrate most rapidly in stigmas of the same species, and progressively slower as the species becomes more distant. When the tube penetration was slow in these crosses, it became continuously slower as the depth of penetration increased, and finally ceased short of the embryo sac. The writer thinks that he has shown that this behavior is due to shortage of nutrient or stimulative materials and not due to toxic materials. His evidence, however, is not at all against the gradual formation of antibodies, a suggestion made by JOST. Self-sterility and failure to hybridize, so far as it is due to lack of tube penetration, deserves a thorough physiological study in the light of our modern knowledge of antibodies and of several other phases of physiology. The later evidence (perhaps not entirely conclusive) that the character of self-sterility mendelizes does not subtract in the least from the need of such an exhaustive physiological study.—WILLIAM. CROCKER.

A new type of embryo sac.—The evolution of the sporophyte and the gradual reduction of the gametophyte are well known to every botanist. In the angiosperms, where the reduction of the gametophyte generation is most extreme, intensive research has revealed several types of embryo sac. Doubtless the most common type and the one long believed to be practically the only type is the familiar 8-nucleate sac, two of whose nuclei fuse to form the endosperm nucleus. This sac is formed by one of a row of 4 megaspores. Soon the *Lilium* type, looking like the preceding but formed from 4 megaspores, was discovered. Sacs with 16 nuclei, some formed from four megaspores and some from a single megaspore, were added to the list. *Cypripedium* has a 4-nucleate sac formed from two megaspores. Since the discovery of the *Cypripedium* type, other 4-nucleate sacs have been found, some formed from one megaspore and some from two.

A new type of embryo sac has been found in *Plumbagella*, one of the Plumbaginaceae.[7] The development starts as in *Lilium*, there being 4 megaspores, not separated by walls, but there are no further nuclear divisions. One nucleus becomes the nucleus of the egg, two fuse to form an endosperm nucleus, and the remaining nucleus, which is at the antipodal end of the sac, disintegrates. At the time of fertilization, there are only two nuclei in the sac. The most important feature is that a megaspore functions directly as the egg. The fusion of two megaspore nuclei to form an endosperm nucleus is also new. Without question, this is the most reduced female gametophyte ever described, and in the nature of the case the reduction can go no farther. DAHLGREN recognizes that the reduction is as extreme as in animals, and he compares this sac with the egg and three polar bodies.

[7] DAHLGREN, K. V. OSSIAN, Der Embryosack von *Plumbagella*, ein neuer Typus. Arkiv für Botanik 14:1–10. *figs. 5.* 1915.